NON-PUBLIC?: N
ACCESSION #: 9111070160
LICENSEE EVENT REPORT (LER)

FACILITY NAME: Oconee Nuclear Station, Unit 1 PAGE: 1 OF 11

DOCKET NUMBER: 05000269

TITLE: Unit Trip for Unknown Reason, Possible Inappropriate Action
EVENT DATE: 05/16/91 LER #: 91-006-01 REPORT DATE: 10/29/91

OTHER FACILITIES INVOLVED: DOCKET NO: 05000

OPERATING MODE: N POWER LEVEL: 100

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR SECTION:
50.73(a)(2)(iv)
OTHER - 50.72(b)(2)(ii)

LICENSEE CONTACT FOR THIS LER:
NAME: Henry R. Lowery, Chairman, TELEPHONE: (803) 885-3034
Oconee Safety Review Group

COMPONENT FAILURE DESCRIPTION:
CAUSE: SYSTEM: COMPONENT: MANUFACTURER:
REPORTABLE NPRDS:

SUPPLEMENTAL REPORT EXPECTED: No

ABSTRACT:

On May 16, 1991, at 1507 hours, Unit 1 tripped from 100 % Full Power, during a thunderstorm. The unit Events Recorder failed immediately prior to the trip, so it is unknown which trip signal was received first. Computer and Chart Recorder outputs indicated that an Instrument and Electrical (I&E) Technician may have erroneously opened the high pressure impulse line isolation valve instead of the low pressure valve on a non-safety related Reactor Coolant System flow transmitter following calibration. This may have caused a momentary dip in the pressure signal to four channels of Reactor Protective System flow instruments which share the impulse lines from the flow element. The pressure dip would have caused a trip on Flux/Flow/Imbalance. Alternatively, the trip could have occurred due to a switchyard transient. Operators took immediate action to stabilize the unit following the trip. The root cause is Unknown, Possible Inappropriate Action. Additional investigation

performed during a subsequent Unit 1 refueling outage failed to clarify the cause.

END OF ABSTRACT

BACKGROUND

The Reactor coolant System (RCS) EIIS:AB! has two steam generators with associated pumps, piping, and instrumentation. These are designated Loop A and Loop B. The flow indications for each loop are provided by one flow element with one pair of impulse lines which run through a secondary shield wall inside the Reactor Building EIIS:NH!. The impulse lines act as headers and are connected to several differential pressure transmitters EIIS:XT!, which are all mounted on the secondary shield wall, where they are accessible while the unit is at power. Each transmitter can be isolated from the impulse line headers by a calibration valve manifold EIIS:V!. These valve manifolds include isolation valves for the high and low impulse tubing and an equalization valve.

Four of these transmitters are connected to the four redundant channels of the Reactor Protective System (RPS) EIIS:JC!, designated as Channels A, B, C, and D. A fifth transmitter (Channel E) provides the normal input to the Integrated Control System (ICS) EIIS:JA! but one of the RPS channels (Channel A) can be selected to supply the ICS when the Channel E transmitter is being calibrated or is otherwise inoperable.

One of the RPS trip parameters is Flux/Flow/Imbalance. The RPS compares the indicated neutron flux (i.e. power level), RCS flow rate, and the power imbalance (the power produced in the top half of the core minus the power produced in the bottom half of the core). The result is that there is a minimum RCS flow for any given power level, and the unit will be tripped if the flow is less than that minimum on any two of the four RPS flow channels.

The Operator Aid Computer (OAC) EIIS:ID! monitors plant operating parameters and provides data display and alarm functions for the operator. Specifically, the OAC is programmed to monitor the outputs of the RCS flow transmitters. It does so by summing the indicated flows from the two corresponding transmitters on each loop. That is, Channel A flow is the sum of the Loop A and Loop B Channel A transmitters' flow indications, etc. The RPS flow channel calculations are performed on either five second or 30 second intervals, depending on the channel. The OAC can alarm for either high or low total flow on each RPS channel. The

ICS channel total flow is calculated every minute, and can alarm on low total flow. There is a flow mismatch alarm for each loop when the Channel A and Channel E transmitters differ by more than a set amount. Those parameters are checked every five seconds.

EVENT DESCRIPTION

On May 16, 1991, Unit 1 was operating at 100 % Full Power. At 1507:47 hours, the unit tripped with no prior warning. The trip response is discussed below. Following the trip plant personnel began to evaluate the cause. The unit Events Recorder EIIS:IQ!, which normally documents significant events in exact sequence to the nearest millisecond, had

failed seconds prior to the trip. As a result, there was no direct indication as to which of the many trip signals received was actually the first trip. The Transient Monitor computer EIIS:IQ! and Operator A
d
Computer (OAC) also record events and data, but are accurate only within a scan cycle and frequently cannot distinguish the first trip signal from the others that follow. Evaluation of the plant status at the time of the trip indicated three potential causes of the trip.

First, a thunderstorm was in progress and had just passed over the plant. A check of relay EIIS:RLY! flags, switchyard oscillographs EIIS:XI!, and witnesses who had been in the parking lot adjacent to the switchyard showed that no lightning strike or voltage surge occurred prior to the trip. The Operations staff and Transmissions Department personnel concluded that the trip was not initiated in the switchyard.

Second, Operations and Instrument and Electrical (I&E) personnel were in the process of troubleshooting to locate a ground in the station 125 Volt DC power system EIIS:EF!. The I&E personnel performing this work were connecting instrumentation to Unit 2 at the time of the trip. Subsequent evaluation by Maintenance Engineering has determined that this work could not have caused the trip.

Third, a calibration of the Reactor Coolant System Loop B, Channel E flow transmitter, which provides input to the Integrated Control System (ICS), was in progress. This instrument shares impulse lines with the Reactor Protective System (RPS) flow instruments for Channels A, B, C, and D. The possibility was recognized for the RPS instruments to be affected while returning the ICS instrument to service following calibration, therefore this activity was highly suspected as the cause.

On May 14, 1991, two I&E crews entered the Reactor Building (RB) and calibrated the RCS Loop A, Channel C (RPS) and Channel E (ICS) flow transmitters. These activities were performed successfully with no system upsets. I&E Technician A was the lead technician on the crew which calibrated the Channel E (ICS) flow transmitter.

On May 16, I&E Technician A entered the RB at 1355, accompanied by a contract vendor, Technician B, to calibrate the RCS Loop B, Channel E flow transmitter. They were communicating via radio with Technician C, at a computer console at the back of the control room. In accordance with the calibration procedure, they had manually selected the alternate channel, Channel A, to provide the RCS flow signal to ICS and the control room chart recorder during the calibration.

The I&E Techs performed the calibration between 1400 and 1507 hours. Associated OAC alarms are listed on Attachment A. As part of the calibration, the instrument had been isolated from the impulse line headers using the calibration valve manifold. At the end of the

calibration, I&E Techs A and B disconnected the test equipment, and re-installed the caps on the test tee fittings. Tech B then began to pack up tools and test equipment in preparation for leaving the RB.

Tech A states that, in accordance with procedural precautions, he began to open the manifold low pressure isolation valve very slowly in an attempt to avoid any affect on the other flow instruments sharing the impulse header. When the valve stem had moved slightly, Tech A and B observed that the RB lights blinked and Tech A thought that the unit might have tripped. (NOTE: Typically the first indication to plant personnel of a unit trip is a momentary loss of lights as the unit auxiliary loads are transferred from the normal source to the start-up source.) The OAC indications for this period shows that at 1507:46 the Channel E total flow cleared a low flow alarm, indicating that the instrument was at least partially valved into service, and at 1507:47 the unit tripped.

Tech A states that he initially reclosed the low pressure isolation valve. He thought about the situation and decided that, if the unit had tripped, his beat course of action was to go ahead and complete his task. Therefore, he fully opened the low pressure isolation valve, closed the equalization valve and opened the high pressure isolation valve, restoring the instrument to service. During this time, Techs A and B heard announcements over the radio channel that Unit 1 had tripped. Then Tech A completed action steps to install covers on the transmitter and

Tech B independently verified that the block of steps returning the instrument to service had been performed. They finished gathering up tools and test equipment, and exited the RB.

At 1507:47, Control Room Operator (CRO), CRO A, was "at the controls," monitoring operation when Unit 1 tripped without any prior warning. He proceeded to perform the designated post trip manual operator actions and to confirm proper automatic responses occurred. Control Room Senior Reactor Operator A opened EP/1/A/1800/01, "Emergency Operating Procedure" and began reading the procedure steps to the CROs, who performed the necessary verifications and actions.

The immediate response of the plant was normal for a trip. All Control Rod Drive EIIS:AA! breakers opened and the control rods dropped into the core. The turbine generator tripped, both 4kv and 7kv electrical power supplies transferred to the start-up source, the turbine stop valves closed, the main steam relief and turbine by-pass valves opened.

The Primary system response was normal. Reactor Coolant System (RCS) pressure dropped from 2131 psig prior to the trip to approximately 1827 psig following the reactor trip, and then increased and controlled at approximately 2131 psig. Pressurizer EIIS:VSL! level was initially at approximately 220 inches and decreased immediately after the trip. CRO A started a second High Pressure Injection (HPI) EIIS:BG,CB! pump at 1508:16 and opened the

HPI Loop A Emergency Make-up Valve (HP-26) at 1508:27 to increase make-up to the RCS in order to keep Pressurizer level above the Pressurizer heater banks. CRO A observed that the Pressurizer level did not immediately respond to the increased flow from the second pump. However, he misread the indication as approaching 30 inches and decided to also start a third HPI pump. As he turned the switch at 1508:29, CRO B advised him that it was unnecessary so he stopped the third pump at 1508:38. Moments later the Pressurizer level reached an indicated minimum of 70 inches and began to increase. At 1510:21 hours, CRO A closed HP-26 and secured the second HPI pump. Pressurizer level reached approximately 150 inches five minutes after the trip, then slowly declined to 115 inches. RCS Hot Leg temperatures decreased from approximately 600 F and RCS Cold Leg temperature decreased from 560 F and converged to a minimum of 554 F and stabilized at approximately 555 F.

Secondary response was also as expected. Following the trip, Main Steam EIIS:SB! system pressure initially increased to 1112 psig. The Turbine Bypass Valves EIIS:SO! opened to lower Main Steam pressure to its proper post trip value of 1010 psig. However, the operators took manual control of the turbine bypass valve setpoint to lower the Main Steam header pressure approximately 11 minutes after the trip to allow one of the Main Steam relief valves on Main Steam header A to reseat at 979 psig.

Feedwater flow and corresponding Steam Generator levels responded appropriately. Following the reactor trip, Feedwater flow decreased and Steam Generator levels reached a minimum level of 21 inches before controlling at 25 inches.

By 1530 hours the unit was at stable hot shutdown, and the transient was terminated.

During the post-trip review, several discrepancies were observed.

First, the unit Events Recorder went out of service less than ten seconds prior to the unit trip. The immediate cause was identified as a trip of the internal power supply breakers but no root cause has been found to explain why those breakers tripped. Because the Events Recorder was inoperable at the time of the trip, there was no direct indication as to which of the many trip signals received was actually the first trip.

Second, several components (Vacuum priming pump, Lube oil purifier, generator stator coolant panel) tripped or required manual restart after the trip. This indicates that the transfer from normal to start-up auxiliary power was not a "rapid transfer" (less than one second). A rapid transfer should occur if switchyard power circuit breakers (PCB) 20 and 21 are still closed when the transfer occurs. If PCB 20 and 21 are open, a one second time delay is imposed by the transfer logic.

The Transient Monitor did not show the same post-trip values for several parameters, especially pressurizer level, as was indicated by other devices.

Additional testing was performed during the shutdown for a scheduled refueling outage which began August 1, 1991. After the unit was brought to hot shutdown and the control rods fully inserted into the core, I&E technicians repetitively valved the Channel A and Channel E flow instruments out of service, vented the instrument as would be done during calibration, and then valved the instruments back into service while monitoring the outputs of all the instruments sharing the impulse header. On each attempt they used varying sequences when operating the isolation block valves. The only operation which produced any affect on the adjacent transmitters was when one instrument was intentionally valved in by opening the high and low isolation valves while the equalization valve was left open. As expected, this resulted in a low flow indication on the adjacent transmitters.

CONCLUSIONS

The root cause of this event is Unknown, Possible Inappropriate Action. Because the Events Recorder was not available, it is unknown which trip signal was received first.

A switchyard initiated trip could result in power circuit breakers 20 and 21 tripping early in the trip sequence, leading to the resultant trip of several miscellaneous loads. However, the loss of those loads does not provide conclusive evidence that the trip was initiated in the switchyard. Previous switchyard initiated trips have produced a momentary loss of power to the reactor coolant pumps, which in turn, resulted in a momentary decrease in reactor coolant flow which resulted in receipt of a Flux/Flow/Imbalance trip. However, any switchyard initiated trip should have resulted in additional indications such as relay flags which were not observed during this trip. A refueling outage occurred between August 1, 1991 and September 29, 1991 during which no defect was discovered by testing, inspections, and/or maintenance which would have caused a trip with the observed combination of data and indications.

No potential scenario has been advanced to give any reasonable connection between the Unit 1 trip and the problem with the station DC ground system.
The third potential cause, a transient in the Reactor Coolant Flow instrumentation during return to service of one instrument, is considered to be the most probable cause, but cannot be conclusively proven.

At the end of calibration of the flow instrument, the instrument was at atmospheric pressure. When the instrument was valved back into service, it was subjected to Reactor Coolant System

(RCS) pressure of 2155 psig. In this situation, a short transient may be seen by the other transmitters as the calibrated instrument re-pressurizes and any air bubbles are collapsed. If the instrument is valved in properly, the low pressure impulse line pressure may dip momentarily, which may cause the adjacent flow instruments to indicate a higher pressure drop and, therefore, a higher flow. This phenomenon was the apparent cause of an indication on a control room chart recorder for total RCS flow when Tech A returned the Loop A, Channel E instrument to service on May 14, 1991. If the high pressure impulse line is valved in first, instead of the low pressure impulse line, any momentary dip in pressure should be seen on the high pressure side of the adjacent instruments, causing a momentary indication of a lower pressure drop across the flow element and, therefore, a lower flow indication. The control room chart recorder showed such a decrease in indicated flow at the approximate time of the trip.

The Operator Aid Computer (OAC) shows several alarms received as a result of the calibration of the RCS flow transmitter (see Attachment A). At 1507:46, the OAC indicates that the loop B transmitter output went close to or above full scale, and stayed there for several minutes. The Unit tripped approximately one second after this OAC indication. This indication could occur if the instrument were valved into service completely. However, Tech A stated that the lights blinked off while he was operating the first valve, indicating that the trip occurred prior to the instrument being valved in completely. Therefore, it could only have shown increased flow if Tech A had opened the HIGH pressure impulse line isolation valve, rather than the LOW pressure valve he intended to open.

Additional testing was performed August 1, 1991 during shutdown for the refueling outage by varying the sequence when valving the instrument back into service. This testing did not produce any transient effects on the adjacent transmitters except when both the high and low taps of the instrument were valved in with the equalization valve left open. Therefore, all identified transmitter transient scenarios require operation of either the wrong valve or more than one valve to initiate the transient.

However, Tech A feels certain that he operated the correct valve. The valves on the manifold are not specifically marked or labeled as to which is high pressure and which is low pressure. However, the instrument ports are marked. Furthermore, it is virtually impossible to successfully calibrate the instrument without being fully aware of which is the high pressure side. Tech A states that he fully understood which side was the high pressure side. He had successfully performed this action in the past, as recently as two days prior to this event. He was well aware of the possibility of unit trip if the wrong tap was un-isolated first and/or if the instrument was valved in too rapidly. It is possible that he did not adequately self check his selection when reaching for the valve to open it. One mitigating factor was the working environment. They had been inside containment, at power, wearing anti-contamination clothing in a general area temperature of approximately 95 degrees, for approximately one hour.

At 1510:25, after the trip, the OAC total % flow decreased to 65 %, which indicated that the ICS transmitter output went to zero. Within seconds, two of the four RPS transmitters' indicated flow slightly below their alarm setpoints. This indicates that the high, low and equalization valves were all open at this time, allowing flow through the valve manifold and affecting the pressure differential between the high and low pressure impulse lines. At 1511:18, the ICS flow again returned to normal, indicating that the equalization valve was again closed. Again, within seconds, the RPS transmitters' indicated flow increased to clear the low flow alarms. However, Tech B states that neither he nor Tech A operated the equalization valve after it was closed earlier. Independent Verification (IV) of the manifold equalization valve was performed by attempting to close the valve further rather than by opening and re-closing it.

As indicated on the appropriate enclosure of the procedure, each of the steps in returning the instrument to service requires IV. Statements by Tech B indicate that his attention was primarily on packing up equipment during the actual performance of these steps. Tech B states that he performed the IV after the completion of the block of steps restoring the instrument to service rather than after each valve was operated. However, verification after the fact is permitted by directive, so that, if Tech B had performed prompt IV immediately after operation of the wrong valve by Tech A, he could have only confirmed that the wrong valve had been operated, and the unit trip would still have occurred. Station Directive 2.2.2 on Independent Verification, paragraph 4.13 states "Where applicable, consideration should be given to the reaching of an agreement between the performer and verifier that the component or system is the correct one prior to performing the action required by the step in the procedure." This prior agreement step was not performed for the action of returning this instrument to service. Therefore, it is concluded that the method of IV performed by Technicians A and B does not meet the intent of the directive.

The operators took prompt action to control and mitigate the trip. The post-trip response was in accordance with EP/1/A/1800/01, "Emergency Operating Procedure." except for the start of the third High Pressure Injection (HPI) Pump by CRO A. CRO A's action to start the pump was inappropriate because it was based on misreading an instrument and because it resulted in an unnecessary Allowable Operating Transient Cycle on the HPI Loop B injection nozzles. While this action was inappropriate for the actual tank level, it would have been the correct response for the lower level he thought existed. This was CRO A's first trip outside of simulator training.

There have been no unit trips due to a root cause of Unknown, Possible Inappropriate Action within the last two years. Therefore, at this time, this event is not considered to be recurring.

There were no NPRDS reportable equipment failures discovered in association with this event. There were no personnel injuries, no releases of radioactive materials, or excessive exposures associated with this event.

CORRECTIVE ACTIONS

Immediate

1. Operators took appropriate action to stabilize the unit at hot shutdown.

2. The Events Recorder power supply breakers were reset.

Subsequent

1. I&E personnel evaluated the possibility for a ground fault or the battery ground detector test to have caused this trip. Their evaluation eliminated those as potential causes.

2. Transmission personnel examined relay and oscillograph indications of lightning and/or switchyard problems as potential causes. No such causes were immediately apparent.

3. Maintenance Engineering Services and the Instrument and Electrical section did additional testing during the subsequent Unit 1 refueling outage, but could not identify the cause of this trip.

4. Performance and I&E evaluated the feasibility of reducing power to preclude/minimize the possibility of a flow/flux imbalance trip as a result of maintenance on RCS flow transmitters. Based on the results of the testing during shutdown, they concluded that a transient should not occur unless an error is made in valving in the instrument. If the equalization valve is inadvertently left open, the unit would trip even if at reduced power. Therefore, reducing power for RCS flow

transmitter maintenance/calibration is not required.

5. CRO A was counseled concerning the deficiency in his action of starting the third High Pressure injection pump.

Planned

1. Maintenance Engineering Services is evaluating a change of Rosemount transmitter circuit boards to a model with a signal filter to slow down transmitter response to short signal spikes.

2. Maintenance Engineering Support will do further investigation to determine the cause of why Events Recorder power supply tripped.

SAFETY ANALYSIS

The reactor apparently tripped either on Flux/Flow/Imbalance due to the spurious low flow indications resulting from improperly valving in a flow transmitter after calibration or on an anticipatory trip due to a turbine generator trip for unknown reasons. The Reactor Protective System operated as designed and tripped the unit. The plant post-trip response was normal and aB expected. No Engineered Safeguards system or emergency feedwater actuations were either required or received.

Operator action maintained all parameters within nominal post-trip values. One operator momentarily misread the pressurizer level and started a third High Pressure Injection (HPI) pump unnecessarily. While this action was inappropriate for the actual level, it would have been the correct response for the lower level he thought existed. The only consequence of this action was a recordable Allowable Operating Transient Cycle on the injection nozzles on the affected HPI train.

The health and safety of the public was not endangered by this event.

Attachment A

Operator Aid Computer Flow Alarms

TIME ALARM
1455:36 LOW RC Flow 89 %

1455:40 NORM Loop B flow mismatch 0.909 psid
1455:45 HIGH Loop B flow mismatch 5.048 psid
1456:55 LOW Loop B flow mismatch -13.702 psid
1457:36 NORM RC Flow 123 %
1458:50 NORM Loop B flow mismatch - 2.243 psid
1458:50 LOW RC flow 95 %
1459:05 HIGH Loop B flow mismatch 7.584 psid
1459:53 NORM RC Flow 121 %
1501:40 NORM Loop B flow mismatch 0.908 psid
1501:45 LOW Loop B flow mismatch -4.268 psid
1504:19 LOW RC Flow 78 %

1507:46 NORM RC Flow 115 %

1507:47 UNIT TRIP

1508:45 NORM Loop B flow mismatch 1.624 psid
1510:25 LOW RC Flow 65 %
1510:33 LOW RP CH D TOTAL CLNT FLOW 133064 KLBH
1510:35 LOW RP CH A TOTAL CLNT FLOW 133290 KLBH
1511:18 NORM RC Flow 114 %
1511:24 NORM RP CH D TOTAL CLNT FLOW 134144 KLBH
1511:28 NORM RP CH A TOTAL CLNT FLOW 134144 KLBH
1512:53 LOW RP CH B TOTAL CLNT FLOW 132974 KLBH
1514:38 NORM RP CH B TOTAL CLNT FLOW 134280 KLBH
1515:22 LOW RP CH A TOTAL CLNT FLOW 133244 KLBH
1515:53 NORM RP CH A TOTAL CLNT FLOW 134144 KLBH
1519:25 LOW RP CH B TOTAL CLNT FLOW 132974 KLBH
(DID NOT RESET PRIOR TO 1526)

NOTE: % values are % of initial design flow.

ATTACHMENT 1 TO 9111070160 PAGE 1 OF 1

Duke Power Company (803)885-3000
Oconee Nuclear Station
P.O. Box 1439
Seneca, SC 29679

DUKE POWER

October 30, 1991

U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Subject: Oconee Nuclear Station
Docket Nos. 50-269, -270, -287
LER 269/91-06, Revision 1

Gentlemen:

Pursuant to 10 CFR 50.73 Sections (a)(1) and (d), attached is Licensee Event Report (LER 269/91-06, Revision 1 concerning a unit trip. This supplement includes the results of outage testing and investigations into the cause of the trip. This report is being submitted in accordance with 10 CFR 50.73 (a)(2)(iv). This event is considered to be of no significance with respect to the health and safety of the public.

Very truly yours,

H. B. Barron
Station Manager

RSM/ftr

Attachment

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NRC Resident Inspector
Oconee Nuclear Station

*** END OF DOCUMENT ***
